INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 9, No. 6, p. 121-134, 2016
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

An analysis of socio demographic and agronomic factors associated with adoption of improved mango varieties among small scale farmers in Alego Usonga sub-county

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Article published on December 31, 2016

Key words: Adoption, Improved mango, Socio demographic, Factors

Abstract

The adoption of improved mango in Alego Usonga was still low covering an area of 12 Ha out of 47800 Ha of the arable land constituting only 0.025 %. The objective of this study was to determine the agronomic and demographic factors that influence adoption of improved mango varieties in Alego Usonga Sub County. The study adopted a cross sectional design to interview selected mango farmers who adopted planting of improved varieties. The study population was 320 famers witha sample size of 178. The collected data was analyzed using descriptive statistics, binomial regression analysis and chi-square test for inferential statistics at the 5% level of significance to determine differences with the aid of SPSS version 20.0 computer software. These results that were statistically significant and positively influenced improved mango adoption included, The Gender of respondents (OR=2.4;95% CI=(1.3-4.0), p=0.006) occupation(OR=2.5;95%CI=(1.1-5.7),p=0.028), education levels (OR=0.2;95% CI=(0.4-0.9), p=0.043), land ownership type (OR=4.35;95% CI=(2.16-8.78),p=0.010), household size (OR=2.26;95% CI=(1.22-4.21), p=0.0001), soil fertility improvement measures (OR=7.09; 95% CI=[3.5-14.3], p=0.0001), use of manure and inorganic fertilizers (OR=4.4;95% CI=(2.27-8.53), p≤0.0001), location (OR=10;95% CI= (1.6-63.0), p=0.043), (OR=5.8;95% CI=(1.7-20.6), p=0.006) and (OR=3.6;95% CI= (1.3-10.2), p=0.01), time of holes preparation (OR=3.53; 95% CI= [1.87-6.68], p=0.0001) and spacing (OR=5.63; 95% CI= [2.88-11.0], p=0.0001) and source of seedlings (OR=7.82; 95% CI= [1.78-34.45], p=0.007) The study recommends that the stakeholders in mango industry in Siaya County should have a Programme in place focusing on the females farmers; households with young families' and assist farmers in acquiring land title deeds to increase mango adoption.

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Introduction

The adoption of improved mango is very low in Alego Usonga Sub County. The improved mango constitutes only 10% of total mango production in the sub county which covers a total of 12Ha, Alego Usonga Ministry of Agriculture, Livestock and Fisheries annual report [2014].] Compared to total available land of 47800 despite the fact that the area is very conducive for improve mango adoption. This low adoption was the basis for this research andtheaim of this study was to investigate the agronomic and demographic factors that influence adoption of improved mango varieties in Alego Usonga Sub County.

Location was considered in the research in terms of agro ecological zones. Maingi, [2008] refers to Agro-Ecological Zoning as the division of an area of land into smaller unit which have similar characteristics related to land suitability, potential production and environmental impact for adoption of improved mango, The Land size owned of the farmers was looked at, Rudulp *et al*, [1991] found that the bigger the farm size the more the flexibility for crop rotations which could influence adoption. The possible causes this low adoption is due to land ownership where women and youths who are involved in farming do not own land and cannot make decisions on a locating land for planting of permanent crops like improved mango, Rudulp *et al*, [1991] found that land was a proxy to security necessary as farmers would invest more on land that they have secure rights over cases where land is communally owned and of lesser entitlement. Mango was a permanent crop that was less likely to be grown on a rented or leased or communal land hence the majority of farmers adopting planting of the crop has title deed. Lack of access to high quality mango seedlings also hinder adoption of improved mango due to high transportation cost. High costs of manure and fertilizers, Jama *et al* [1999] observed that both organic and inorganic fertilizers applications significantly increased leafy yield through its influence on leaf number of *Brassica oleracea* var *acephala* L.

The household size may also influence adoption, Studies done by Mafuru *et al*, [1999], on maize adoption found that because larger households were more likely to provide the labour that might be required by improved maize technologies, a larger household size would be expected to increase the probability of adopting improved maize variety. Rudulp *et al*, [1991] asserted that more farmers would adopt a technology that requires less capital than those that would require more capital**.** Education level is also important in the adoption of technology. Studies by Goswan and Sagar [1994] showed that educated farmers are expected to display better adoption of technology because their ability to understand the benefits from such technology and thrust in extension offices.

Gender is considered an important variable within the household because gender determines the way resources were used and property ownership. This is due to social-cultural factors that create differentiated impact on male and female farmers' access to agricultural extension programs and property ownership, Orodho, [1996] Historical women's productive roles have been ignored or undervalued particularly in the informal sector and subsistence agriculture. This has led to misconceived development of projects e.g. services of extension agents and inputs being targeted at men. Because women's labour is undervalued, it is often assumed by mainstream development policies to be infinitely elastic e.g. policy makers expect women to take on roles fulfilled by public services e.g. caring for the sick and elderly. Culturally, women and youths do not own land therefore cannot make decision in planting of perennial crops such as mango, lowering adoption. Damisa *et al*, [2007] reported that Nigerian women contribute a lot to food production although their contributions have often been undervalued. Therefore as home makers, more women than men may be involved in farming in order to fulfill what their home's needs.

Materials and methods

Location of the study

Alego Usonga Sub-County is in the Siaya County Kenya with a surface area of 703.9km ² out of which 478 sq. km was cultivatable land and 120.3sq.km was non arable land. It has six administration wards namely Usonga, West Alego, Siayatownship, South East Alego, Central Alego and North Alego Wards. It borders Gem sub County to the North, Ugenya and Ugunja to the west and the entire south borders Bondo Sub County. The altitude of Alego Usonga Sub County rises from 1,140m in the eastern parts to 1,400m above sea level in the west. There were few hills found in the sub county and River Nzoia and Yala at the borders of the Sub County on the north and south respectively and enter Lake Victoria through the Yala Swamp.

The main soil type was ferrasols and its fertility ranges from moderate to low with most soils unable to produce without the use of either inorganic or organic fertilizers. Alego Usonga sub county has a bimodal pattern of rainfall with long rain falling between March and July, ranging between 450mm to 600mm and short rain between September and December, ranging between 300mm to 500mm. Temperature ranges between 15°C and 21°C and the evaporation rate was 1800-2000 mm per year, The Siaya County, County Integrated Development plan 2013-2017; The total population of Alego Usonga County as at 2012 was estimated to be 197,049 persons, KNBS, (2012). It Comprises 92,085 males and 104,965 female, with an annual growth rate of 1.7%. The population was projected to increase to 214,541 persons by 2017, The Siaya County, County Integrated Development plan 2013-2017.

The study was conducted in Alego Usonga Sub County where local mango grows naturally. The study was confined to small holder farmers who grow improved mango in Alego Usonga. The study mainly targeted the various farmer groups who had earlier been trained on the production, utilization, processing and marketing of mango and their linkages with research and extension service providers and varieties of improved mango adopted.

A cross sectional study was carried out to interview selected mango farmers who were trained on factors influencing planting of improved mango varieties. The study employed survey research design which helped in finding out the data of the variables being studied and was able to cover the population adequately when sampling was being done. A sample survey was also cost and time effective.

Target population

The target population refers to a group of items or objects or people from which samples were taken for measurement, Mugenda and Mugenda, [1999]. The target population was farmers who were residents of Alego Usonga Sub County who grow improved mango varieties. The sampling frame was the list of mango groups which have been previously trained by the world vision, Ministry of Agriculture and ASDSP. The mango groups included a total of six farmer group namely Nyadiangamoyie women group, Murmalangaself-help group, Karemowater point, Ukulima bora, Nyabera youth group, Biidii young farmers and Lala farmers group, with a total population of 320 improved mango farmers.

Sample Size Selection and Sample Size calculation.

Purposive sampling was used to select Alego Usonga sub County and the 6 improved mango groups represented a larger section of the region.

A simple random sampling using stratified sampling was used to select the respondents from the formulae as shown Table 1. below to draw sample size.

The formula used for generating samples was by Israel, [2009] the sample size was calculated as follows: $n = \frac{N}{1+N\,(e)^2}$

Where,

- n = desired sample size
- N = Population size of the total households involved in the study
- e = Desired level of statistical precision. (±5 margin of error the precision level is 0.05)

Using this formula the sample size was the generated as below:

$n = \frac{320}{1+320(0.05)^2} = 177.8$ which is approximately 178 to the next integer the sample size was 178 farmers.

Sampling Strategy

A simple random sampling using stratified sampling was used to select the respondents from each farmer group as shown in Table 1. Systematic sampling of farmers at interval of two derived from

$$\text{Sampling interval} = \frac{\text{Total smple frame}}{\text{Sample size}}$$

Data Collection Procedures

Data collection instruments used was structured questionnaires which was segmented to meet each of the objectives of the study and administered to the trained improved mango farmers.

One focused group discussion was held in order to capitalize on group dynamics and increase level of focus on key issues. Semi structured interviews was administered to key informants in the mango sectors in the Sub county.

A check list was used to help in capturing information on factors that influence adoption, availability of extension service providers and research on suitability of improved mango varieties in Alego Usonga. Secondary information was assembled from literature and journals. 5 questionnaires were pretested and corrected before administering to the respondents to minimize errors.

Table 1. Sample size distribution per group and their location in Alego Usonga Sub County.

Group	Target population	Sample size	Locations coverage
Biddii youth group	48	27	North /central Alego
Lala farmers group	53	29	South East
Ukulimabora Nyabera youth group	60	33	West and south west Alego
Karuma water point	46	26	South Alego/South west Alego
Malangaself-helpgroup	57	32	South ,south east and township
Nyadengemoyie women group	56	31	Usonga
Totals	320	178	

Source: author (2016).

Validity of instruments

A pretest of the instrument was done for verification purposes, the validated instruments were used for field work. This was to ensure clarity in interpretation and assist to improve the instrument before the actual data collection. Selected teams of peers and experts in agriculture extension were requested to review the questionnaire and its items. The guidelines for experts review focused on representative ness of the objectives and variables coverage as well as ability of the items based on their flows and ability to elicit the intended data and responses. Appropriate adjustments was made on the content item construction and order of the items in the questionnaire based on the suggestions/ recommendations for this initial review, before administering it for the pilot study.

Data analysis

Microsoft Excel software was used for data entry and cleaning. The cleaned data was first imported to the Statistical Package for Social Scientists (SPSS) software, version 20 for simple descriptive statistics and frequency analysis. During data analysis, results were summarized using descriptive statistics. Chi-square (x^2) test was used to assess association between categorical variables. Chi squire (x^2) P-value ≤0.05 were considered statistically significant results. The Chi Square (x^2) statistic was commonly used for testing relationships on categorical variables.

Binomial logistic regression analysis was used to establish the relationship between independent variables to measure the magnitude of association. Odds Ratio and 95% CI were reported. P-value ≤0.05 were considered statistically significant results for predictors of adoption of improved mango varieties was used to infer presence or absence of relationships between variables and also to analyze and determine whether there was a relationship between selected variables direction of that relationship and the strength of the relationship among several variables observed among the respondents, Kothari and Gaurav [2014],

Regression analysis assumes that the independent variable was at least in part a cause or a predictor of the dependent variable these relationships were used to draw conclusions on the factors that influence adoption of improved mango varieties.

Variables in the Study

Independent variables in the study were of measurement type. The Socio-economic variables observed were: gender of the respondents, age of respondents, family size, size of household farm, level of education, location, main occupation of respondent ,other crops grown, keeping livestock and agronomic factors included fertilizer and manure use, spacing, time of holes preparation, source of seedlings, number of visits by service providers.

The dependent variable or criterion variable for the study was the adoption of improved mango varieties.

Results

The agronomic and socio-demographic factor in association with the adoption of improved mango varieties was considered. The socio-demographic factors considered was gender (male or female), occupation of the farmer, education level, the locality, land ownership type, size of land owned by the farmer, size of household and whether the farmer plant local mangoes.

The agronomic factors considered were the use of pesticides or fungicides, soil fertility improved measures, transplanting mango seedlings using manure and fertilizers, source of improved mango seedlings, spacing of improved mangoes and time of land preparation in readiness for transplanting of improved mango seedlings.

Gender of respondents

Amongst farmers who adopted improved mango, 52.4% were females compared to 72.3% who were males. The difference were statistically significant (OR=2.4; 95% CI= (1.3-4.0), p=0.006 as shown in table 4.3. This result indicates that male famers were 2.4 times more likely to adopt improved mango compared to female farmers.

The respondents who were practicing farming only, 66.7% of them adopted compared to 42.9% doing farming and other occupations. The difference in proportions were statistically significant (OR=2.5; 95% CI= (1.1-5.7), p=0.028) as shown in Table 2.

Table 2. Socio demographic factors and association with adoption of improved mangoes amongst improved mango farmers in Alego Usonga Sub County.

Socio Demographic Factors	Adoption		Odds Ratio	(x^2)P value*
	Yes n (%)	No n (%)	95%CI	
Gender				
Female	44 (52.4)	40 (47.6)	2.4 (1.3-4.0)	0.006
Male	68 (72.3)	26 (27.7)		
Occupation				
Others	12 (42.9)	16 (57.1)	2.5 (1.1-5.7)	0.028
Farmer	100 (66.7)	50 (33.3)		
Education Level				
None	8(57.1)	6 (42.9)	Ref	
Primary	42 (58.3)	30 (41.7)	1.0 (0.3-1.2)	0.989
Secondary	40 (58.8)	28 (41.2)	0.9 (0.3-3.0)	0.907
Tertiary	22 (91.7)	2 (8.3)	0.2 (0.4-0.9)	0.043
Location				
North Alego	20 (76.9)	6 (23.1)	Ref	
Central Alego	6 (75.0)	2 (25.0)	1.1(0.2-7.0)	0.911
Usonga	2 (25.0)	6 (75.0)	10(1.6-63.0)	0.014
South East Alego	8 (36.4)	14 (63.6)	5.8(1.7-20.6)	0.006
West Alego	0 (0.0)	2 (100.0)	5.4(0.0-99)	0.999
East Alego	4 (50.0)	4 (50.0)	3.3 (0.6-18)	0.155

Socio Demographic Factors	Adoption		Odds Ratio	(x²)P value*
	Yes n (%)	No n (%)	95%CI	
South West Alego	36 (94.7)	2 (5.3)	0.4(0.1-1.6)	0.184
South Alego	28 (48.3)	30 (51.7)	3.6 (1.3-10.2)	0.017
Township	8(100.0)	0(0.0)	N/A	0.999

*P values were generated through chi-square test and values in bold were statistically significant at p≤0.05. Odds ratios were generated through binary logistic regression. n= number of respondents.

Education level of respondents

The education levels of the respondents who adopted improved mango, 91.7% had tertiary education as compared to 57.1% of those who had no education. The difference was statistically significant (OR=0.2; 95%CI= (0.4-0.9), p=0.043). Those who had secondary education, 58.8% adopted improved mangoes compared to 57.1% of those who had no education. The difference was no statistically significant (OR=0.9; 95% CI= (0.3-3.0), p=0.907) as shown in Table 2. Those respondents who had primary education, 58.3% adopted improved mangoes compared to 57.1% of those who had no education. The difference was not statistically significant (OR=1.0; 95% CI= (0.3-1.2), p=0.989).

Location of respondents

North Alego location had 76.9% adoption, Alego Usongalocation 25%, South East Alego36.4% and South Alego 48.3% the differences was statistically significant (OR=10; 95% CI= (1.6-63.0), p=0.043), (OR=5.8;95% CI= (1.7-20.6), p=0.006) and (OR=3.6;95% CI=(1.3-10.2), p=0.017) respectively and central Alego, west Alego, East Alego, south west Alego and township was statistically not significant {(OR=1.1:95% CI=(0.2-7.0)), p=0.911, (OR=5.4:95% CI=(0.0-99), p=0.999), (OR=3.3:95% CI=(0.6-18), p=0.155, (OR=0.4:95% CI=(0.1-1.6), p=0.184) and township location with p=0.999.

Type of land ownership and land size

The landownership type of the farmers who adopted improved mango, 72.3% had title deed compared to 37.5% who rented land or did not have title deed. The difference was statistically significant (OR=4.35; 95% CI=(2.16-8.78), p=0.010) as shown in Table 3. This result shows that famer with title deeds was 4.35 times more likely to adopt improved mango as compared to those without land title deeds. The land size of the respondents who adopted improved mangoes,57.1% had more than 5 acres compared to 63.4% of those farmers who had 0,5 -5 acres. The difference was not statistically significant (OR=0.77; 95% CI= (0.26-2.32), p= 0.642) as shown in Table3.

Table 3. The relationship between farmers' information and adoption of improved mango varieties.

Farmers Information	Adoption		Odds Ratio (95% CI)	(x²)P value
	Yes n (%)	No n (%)		
Type of land ownership				
Owned by title deed	94 (72.3)	36 (27.7)	Ref	
Others	18 (37.5)	30 (62.5)	4.35(2.16-8.76)	0.0001
Size of Land				
0.5 - 5.0	104 (63.4)	60 (36.6)	0.77(0.26-2.32)	0.642
>5.0	8 (57.1)	6 (42.90	Ref	
Size of Household				
3-6	42 (52.5)	38 (47.5)	2.26(1.22-4.21)	0.010
>6	70 (71.4)	28 (28.6)	Ref	
Local Mangoes				
Less than 5	84 (63.6)	48 (36.4)	0.29(0.05-1.62)	0.157
6 – 10	26 (65.0)	14 (35.0)	0.27(0.04-1.66)	0.157
greater than 10	2 (33.3)	4 (66.7)	Ref	

*P values generated through chi-square test and values in bold were statistically significant at p≤0.05. Odds ratios were generated through binary logistic regression. n= number of respondents.

Household size

The household size of the farmers who adopted improved mango, 71.4% had more than 6 family members compared to 52.5% who had 3-6 family members. The difference was statistically significant (OR=2.26; 95% CI= (1.22-4.21), p=0.0001). This result indicates that famers with more than 6 members' was 2.26 times more likely to adopt improved mango compared to those whose family size was between 3 and 6 as shown in Table 3.

Number of local mangoes grown

The farmers who adopted improved mangoes, 63.6% grew local mangoes less than 10 trees compared to 33.3% who grew more than 10 trees of local mango. The difference was not statistically significant (OR=0.29; 95% CI= (0.05-1.62), p= 0.157). Of the farmers adopted improved mangoes, 65.0% grew 6-10 local mangoes. The difference was not statistically significant (OR=0.27; 95% CI= (0.04-1.66), p= 0.157) as shown in Table 3.

Use of fungicides and pesticides

The farmers who adopted improved mango variety, 72.7% Used pesticides or fungicides as compared to 59.7% who did not use pesticides or fungicides. The difference in proportions wasnot statistically significant (OR=1.80; 95%CI= [0.85-3.80], p=0.123) as shown in Table 4.

Use of manure and fertilizer

The farmers who adopted improved mango varities, 77% used soil fertlity improved measures compared to 32.1% who did not use such measures. The difference in proportions was statisctically significant (OR=7.09; 95%CI= [3.5-14.3], p=0.0001) as shown in Table 4. The farmers who adopted improved mango varities,74.6% transplanted Using manure/fertilizer compared to 40% who didTransplant Using manure/fertilizer. The difference in proportions were statistically significant (OR=4.4; 95% CI= [2.27-8.53], p≤0.0001) as shown in Table 4.

The farmers who adopted improved mango varities, 65.8% used farm yard ,manure and inorganic fertilizes compared to 33.3% who didnot use farm yard or inorganic fertilizer**.** The difference was statistically significant (OR=3.84; 95% CI= [1.54-9.59], p≤ 0.00 as shown in Table 4.

Table 4. Relationship between agronomic practices and adoption of improved mango varieties amongst improved mango farmers in Alego Usonga Sub County.

Agronomic for Improved Mango Production	Adoption		Odds Ratio (95% CI)	(x^2)P value
	Yes n (%)	No n (%)		
Use of pesticides or fungicides				
No	80 (59.7)	54 (40.3)	1.80(0.85-3.80)	.123
Yes	32 (72.7)	12 (27.3)	Ref	
Soil Fertility Improvement Measures				
No	18 (32.1)	38 (67.9)	7.09(3.5-14.3)	.000
Yes	94 (77.0)	28 (23.0)	Ref	
Transplant Using manure/fertilizer				
No	24 (40.0)	36 (60.0)	4.40(2.27-8.53)	.000
Yes	88 (74.6)	30 (25.4)	Ref	
Type of manure				
None	8 (33.3)	16 (66.7)	3.84(1.54-9.59)	.004
Farmyard and inorganic	96 (65.8)	50 (34.2)	Ref	
Source of seedlings				
Local	90 (58.4)	64 (41.6)	7.82(1.78-34.45)	.007
Government & NGOs	22 (91.7)	2 (8.3)	Ref	
Spacing of mangoes				
< 8x8m	34 (45.9)	40 (54.1)	3.53(1.87-6.68)	.000
8x8m and above	78 (75.0)	26 (25.0)		
Time Land Preparation				
Other	36 (42.9)	48 (57.1)	5.63(2.88-11.02)	.000
Jan-Feb	76 (80.9)	18 (19.1)	Ref	

*P values were generated through chi-square test and values in bold were statistically significant at p≤0.05. Odds ratios were generated through binary logistic regression, n= number of respondents.

Source of mango seedlings, spacing and time of holes preparation

The farmers who adopted improved mango varities, 92% sourced their seedlings through service providers such us government and NGOs compared to 58% who sourced seedling locally. The difference in proportions was statistically significant (OR=7.82; 95% CI= [1.78-34.45], p=0.007 as shown in Table 4.

The farmers who adopted improved mango varities, 75% spaced the mangos crop above 8°8m compared to 45% who planted the crop closer than 8m.The difference in spacings was statistically significant (OR=3.53; 95% CI= [1.87-6.68], p=0.0001 as shown in table 4. The farmers who adopted improved mango varities, 81% prepared land hole between january and february compared 43% who prepared during any other time of the year. The difference in spacings was statistically significant (OR=5.63; 95% CI= [2.88-11.0], p=0.0001) as shown in Table 4.

Discussion

Amongst farmers who adopted improved mango, 52.4% were females compared to 72.3% who were males. The difference was statistically significant (OR=2.4; 95% CI= (1.3-4.0), p=0.006) as shown in Table 2. Male famers were 2.4 times more likely to adopt improved mango compared to female farmers. This was probably because mango was a permanent crop and the majority of the farmers who plant the crop possess land title deeds. Majority of the females do not own land and therefore less likely to plant mangoes. Gender was considered an important variable within the household because gender determines the way resources was used and property ownership. This was due to social-cultural factors that create differentiated impact on male and female farmers' access to agricultural extension programs and property ownership, Orodho, [1996].

The female farmers who planted the improved mango were those empowered in terms of education, economic or were the head of the households. In his study on women groups in Kenyan Agriculture, Quaim, [2000] found out that some women groups include men as members so that they can lend a hand with heavy physical work.

He reported that cultural reasons and generally higher levels of education of men were additional reasons why they were regarded as more suitable contacts with the service providers. Surprisingly, Statistically influencing several studies have indicated that women in Africa are responsible for up to 60 percent of Agricultural workforce, Damisa *et al.* [2007] reported that Nigerian women contribute a lot to food production although their contribution have often been undervalued. Because women's labour is undervalued, it is often assumed by mainstream development policies to be infinitely elastic e.g. policy makers expect women to take on roles fulfilled by public services e.g. caring for the sick and elderly. Therefore as home makers, more women than men may be involved in farming in order to fulfill what their home's needs. Women groups have experienced problems of acceptance by society when they were on their own. However men were excluded from holding official positions on the committees. A focus on female in terms of empowering them with knowledge and skills will probably increase the adoption of improved mangos in the sub county.

The respondents who were practicing farming only, 66.7% of them adopted improved mango planting compared to 42.9% doing farming and other occupations. The difference in proportions was statistically significant (OR=2.5; 95% CI= (1.1-5.7), p=0.028) as shown in Table 2. Those mango farmers doing farming only were 2.5 times more likely to adopt growing of improved mangoes than those with other occupations because they take farming as their livelihood. They consider mango as their only source of income because mango was a high value crop. Horticultural crops such as improved mango need intensive input by the farmer in terms of pest and disease identification, control and the general management of the mango orchard. Those in other occupation and needs to supplement their income through mango farming needed to employ a manager to take care of the crop and this probably lowers the adoption rate of those in other occupations because of the additional costs. These findings indicated that engagement in other activities would likely limit time available to engage in on-farm activities.

In addition, engagement in other occupation sometimes contributed to rural urban migration which limited access to farm land thereby limiting farming activities. The findings is in contrast with a study by IFPRI [2005] that showed that there was high diversification and strong interactions among agricultural activities and off-farm activities in smallholder farmers' production systems.

The education levels the respondents, 91.7% of those with tertiary education adopted improved mangoes compared to 57.1% of those with no education. The difference were statistically significant (OR=0.2; 95% CI= (0.4-0.9), p=0.043) as shows in Table 2. Education enables one to access information needed to make decision to adopt a practice or technology. Education is also essential for empowering the people. It is expected that education influences adoption of technology positively. Ndiema, [2002] found that education was significant in enhancing awareness and adoption of agricultural technology. Those with secondary education, 58.8% adopted improved mangoes compared to 57.1% of those with no education. The difference were not statistically significant (OR=0.9; 95% CI= (0.3-3.0), p=0.907. The respondents who had primary education, 58.3% adopted improved mangoes compared to 57.1% of those with no education. The difference was not statistically significant (OR=1.0; 95% CI= (0.3-1.2), p=0.989, as shown in Table 2. Quaim [2000] found out that some women groups include men as members so that they can lend a hand with heavy physical work. He also found that because of cultural reasons and generally higher levels of education of men was an additional reason why they were regarded as more suitable contacts with service providers and also some women groups have experienced problems of acceptance by society when they were on their own. This shows that higher level education (tertiary) influences adoption of improved mangoes, this was probably because tertiary education instills new way of thinking and attach value to farming. Improved Mango being a high value crop whose economic life span can be over 300 years, Singh, [1960] the educational level of the farmer is very important for it enhances taking up of new ideas and modern techniques in agricultural production.

This is in agreement to findings by Singha *et al,* (2012) that education level was among the factors that influenced adoption of agricultural technologies and practices under a diversified farming system. Similarly, Fashola *et al.* [2007] established that education level increased the probability of technology adoption by farmers. The probability of adopting improved mangoes significantly increased as the year of education increase. Some studies have reported similar findings, Goswan and Sagar. [1994] ideally, educated farmers are expected to display better adoption of technology because their ability to understand the benefits from such technology and thrust in extension offices. The results show that the higher the education level, the more likely they will have high adoption.

North Alego had 76.9% adoption in the analysis, Alego Usonga location 25%, South East Alego 36.4% and South Alego 48.3% the differences were statistically significant (OR=10; 95% CI=(1.6-63.0), p=0.043), (OR=5.8;95% CI=(1.7-20.6), p=0.006 and (OR=3.6;95% CI=(1.3-10.2), p=0.017 respectively and central Alego, west Alego, East Alego, south west Alego and township was statistically not significant{(OR=1.1:95% CI=(0.2-7.0)), p=0.911, (OR=5.4:95% CI=(0.0-99), p=0.999, (OR=3.3:95% CI= (0.6-18), p=0.155, (OR= 0.4:95% CI=(0.1-1.6), p=0.184 and township location with p=0.999 as shown in Table 2. The statistical significance differences in adoption was probably due to the location distance of the service providers creating awareness of the improved mango varieties to the respondents closer to them and bringing the much needed agronomic information to the farmers. The differences may also be attributed to the agro ecological zones, with North Alego lying in LM 2 receiving more rainfall than south East Alego, south Alego, and Central Alego which were in LM 3 and Alego Usonga and west Alego Which were in LM 4.the reliability of rainfall contributes to the transplanted seedlings surviving and growing to maturity, Maingi, [2008] refers an Agro-Ecological Zoning as the division of an area of land into smaller unit which have similar characteristics related to land suitability, potential production and environmental impact.

The more the rainfall the higher the survival rate of the transplanted improved mango seedlings.the rainfall amounts received in LM1 zones was above 1600mm, LM2 recieved between 1350-1600mm, LM3 received 1100-1350mm and LM4 received 800-1100per annum and mean annual tempreatures for LM zones was 21-24^{o}C, Ralph *et al*, [1982] agreeing with the finding that optimum growth and productivity of mango, 20-26^{o}C was ideal Singh, (1960). Respondents also cultivate other food and cash crops. Diversification was the way to adapt to climate change in order to overcome its effects which causes erratic and poorly distributed rainfall. Monoculture where the communities rely on one particular crop was ill advised. In order to lessen the effect of climate change, there was need to modify our modes of farming by enforcing reforestation and agro forestry as trees were known to alter the micro climate of ecosystem. Improved mangoes serve dual purpose of reforestation and fruit production, Josephine, [2012].

The type of land ownership type of the farmers who adopted improved mango, 72.3% had title deed compared to 37.5% who rented land or did not have land title deeds. The difference was statistically significant (OR=4.35; 95% CI= (2.16-8.78), p=0.010) as shown in Table 3. This result indicates that famers with title deeds were 4.35 times more likely to adopt improved mango compared to those without. This was probably because mango farming was establishing a permanent and a serious investment with high returns of up to 20,000 Kenya shillings per tree per year and any farmer venturing in mango must be sure of the ownership of land, Farm management Guidelines Siaya District [2012]. Mango was a permanent crop that was less likely to be grown on a rented or leased or communal land hence the majority of farmers adopting planting of the crop has title deed. Rented, leased and communal lands at times were dogged with conflict therefore not suitable in establishing this noble crop. Rudulp *et al*, [1991] found that land was a proxy to security necessary as farmers would invest more on land that they have secure rights over cases where land is communally owned and of lesser entitlement.

Women in the study area had no right to own land and therefore cannot decide where to plant any crop.

The land size of the farmers who adopted improved mangoes, 57.1% has more than 5 acres compared to 63.4% of those farmers who had 0,5 -5 acres. The difference was not statistically significant (OR=0.77; 95% CI= (0.26-2.32), p= 0.642) as shown on Table 3. The land size in this case was probably not significant in the adoption because the study was dealing with both small scale and large scale farmers. Some farmers were planting mangoes in the homestead to produce fruits and also act as ornamentals and others planted improved mangoes to satisfy the 10% tree cover enforcement by the forestry department but in agronomy mango farming requires a good size of land for investment. One mango plant at a spacing of 9^{o}9 squires requires 81m^{2} of land, meaning only 50 plants will fit in one acre and at spacing of 10^{o}10 metres; one acre will carry 40 plants. Rudulp *et al*, (1991) asserted that more farmers would adopt a technology that requires less capital than those that would require more capital. However, according to, Rudulp *et al*, [1991] the bigger the farm size the more the flexibility for crop rotations which could influence adoption. The knowledge of stakeholders and actors on policies for improved mango variety production in Alego Usonga sub county.

The household size of the farmers who adopted improved mango, 71.4% had more than 6 family members compared to 52.5% who had 3-6 family members. The difference were statistically significant (OR=2.26; 95% CI= (1.22-4.21), p=0.0001) as shown in Table 3. This result indicates that famers with more than 6 members were 2.26 times more likely to adopt improved mango compared to those whose family size was between 3 and 6. This was possibly because the average household in the area comprises 7 members and that the majority young families were not involved in farming. When the family size grow, they faced with the challenge to get more income and hence the adoption of improved mangos.

Studies done by Mafuru *et al*, [1999] on maize adoption found that because larger households were more likely to provide the labour that might be required by improved maize technologies, a larger household size would be expected to increase the probability of adopting improved maize variety.

The farmers who adopted improved mangoes, 63.6% grew local mangoes less than 10 trees compared to 33.3% who grew more than 10 trees of local mango. The difference were not statistically significant (OR=0.29; 95% CI= (0.05-1.62), p= 0.157 as shown in Table 3. Of the farmers adopted improved mangoes, 65.0% grew 6-10 local mangoes. The difference were not statistically significant (OR=0.27; 95% CI= (0.04-1.66), p= 0.157). The farmers who grew more local mangoes were less likely to grow improved mangoes. The difference was not statistically significant because almost all the farmers who adopted improved mangoes also grew local mangoes. The farmers find local mangoes easy to maintain in terms of weed control and ability to tolerate pests and diseases, Alego Usonga Ministry of Agriculture, Livestock and Fisheries annual report [2014].

The farmers who adopted improved mango variety, 72.7% Used of pesticides or fungicides as compared to 59.7% who did not use of pesticides or fungicides as shown in Table 4. The difference in proportions werenot statistically significant (OR=1.80; 95% CI= [0.85-3.80], p=0.123) because, the farmers adopted planting improved mangoes and uses chemicals for the control of pests and diseases compared to those who did not use any pest and disease control measures who were equally large hence use of pesticide and fungicides has no association with adoption.

The farmers who adopted improved mango varities, 77% used soil fertlity improved measures compared to 32.1% who did not use such measures. The difference in proportions were statistically significant (OR=7.09; 95% CI= [3.5-14.3], p=0.0001) as shown in Table 4. The farmers who use soil fertility improved measures were 7.09 times more likely to adopt improved mango variety compared to those who did not use any soil fertility improvement measures.

This was because the mango farmers were capacity built by the extension service providers on the use of well decomposed manure at the time of transplanting and applying manure to the mango tree annually. For a robust growth of the mango tree application phosphate fertilizer for root development and nitrogenous fertilizer to enhance growth were important.

The farmers who adopted improved mango varities, 74.6% Transplanted Using manure/fertilizer compwered to 40% who didTransplant Using manure/fertilizer. The difference in proportions was statistically significant (OR=4.4; 95% CI= [2.27-8.53], p≤0.0001) as shown in Table 4.This statistical significance was probably due to the impact of the initial trainings done by the service providers. The farmers who transplant using fertilizes/manure were 4.5 times more likely adopt planting improve mangos than those who do not use the manure/fertilizer. The farmers planting improved mangoes were advised to mix the top soil with at least one wheelbarrow of well decomposed manure and refill the hole to allow the mixture to settle for 3 to 4 weeks before transplanting the improved mango seedlings. The manure improves the texture and structure of the soil improving soil aeration and soil water holding capacity hence increasing the survival rate of the seedlings since the soil water holding capacity was enhanced.

The farmers who adopted improved mango varities, 65.8% used farm yard manure and inorganic fertilizes compared to 33.3% who didnot use farm yard or inorganic fertilizer**.** The difference were statistically significant (OR=3.84; 95% CI= [1.54-9.59], p=0.004 as shown in Table 4. Those who use farm yard manure and inorganic fertilizers were 3.84 times more likely to adopt planting improved mangoes than those who do not use. Jama *et al* [1999] observed that both organic and inorganic fertilizers applications significantly increased leafy yield through its influence on leaf number of *Brassica oleracea* var *acephala* L. The use of farm yard manure and inorganic fertilizes was key in establishing a healthy and strong mango trees in the orchard capable of giving the improved mango farmer optimum yield.

The manure, phosghate fertilize and nitogenous fertilizer were added at the root zone yearly to supply the necessary nutrients to the mango crop,usually at the onset of rains. The results and analysis shown in table 2.2, 94% keep domestic animals such as poultry, piggery, bee keeping, horticulture and fish farming to supplement their livelihood. The livestock was used as source of manure this helps in the reduction of costs of purchasing manure and hence increase adoption. The manure was important to the crop in improving the soil texture and structure improving the soil aeration and water holding capacity.

The farmers who adopted improved mango varities, 92% sourced their seedlings through service providers such us government and NGOs compwered to 58% who sourced seedlings locally. The difference in proportions were statistically significant (OR=7.82; 95% CI= [1.78-34.45], p=0.007 as shown in Table 4. Those who source seedlings from extension service providers were 7.82 times more likely to adopt planting improved mango varieties compared to sourcing seedlings locally this was because the farmers were guided on the proper agronomic practices ensuring survival of the crop. The extension service providers also were able to make follows ups in case a farmer needs help. There was need for the fruit tree nursery operators to establish to apply for inspection and certification from HCD to avail quality seedlings for the actors and especially produces at affordable price.

The farmers who adopted improved mango varities, 75% spaced the mangos above 8*8 m compared to 45% who planted the crop closer than 8m.The difference in spacings werestatistically significant (OR=3.53; 95% CI= [1.87-6.68], p=0.0001 as shown in Table 4. The farmers who spaced at 8*8m, 9*9m and 10*10m were 3.53 times more likely to adopt planting improved mango varieties. The correct spacing was probably because of close association with the extension service providers the mango crop needs to be spaced correctly because a close spacing of less than 8*8 m results in the plant canopy reaching the canopy of the next crop after the 7th year thus hampering pollination and the crops shade each other.

Closer spacing may force the farmer to cut some of the mango trees otherwise the farmer would not harvest much fruit because of hampered pollination and shading.

The farmers who adopted improved mango varities, 81% prepared land hole between january and february compared 43% who prepared during any other time of the year. The difference in spacings were statistically significant (OR=5.63; 95% CI= [2.88-11.0], p=0.0001 as shown in Table 4. The farmers who prepared holes in January and February were 5.63 times more likely to adopt planting improved mango varieties compared to other times of the year. The correct time of preparing holes was probably because of close association with the extension service providers the mango crop needs to have holes prepared at the correct time allowing weathering of the holes to occur and refilling of the holes with manure to be done at least 3 weeks before transplanting the seedlings at the onset of the long rains. Timely making holes, weathering of holes and timely refilling of holes and timely transplanting improves survival rate of seedlings, healthy and vigorous growth.

Conclusions

This study has been carried out in Alego Usonga Sub County to investigate the factors that influence the adoption of improved mango varieties. Determine the agronomic and socio-demographic factors that influence the adoption of improved mango varieties in Alego Usonga Sub County. The findings of this study have provided an in-depth analysis of the factors that influence the adoption of improved mango varieties. Agronomic and Socio demographic Factors statistically significant with the adoption of improved mango varieties were found to be the Gender of respondents target the women who are lower in adoption as compared to men. Pure farmers' involvement in farming should be targeted as they are more likely to adopt improved mangoes than those in other occupations. The learned should be targeted, especially farmers with tertiary level of education to increase adoption,

the farmers with Land titles deeds to increase acreage should be targeted to increase adoption, the young families with less than five family members should be targeted for adoption of improved mango, encourage keeping of livestock and bulk purchase of fertilizers to increase adoption by enabling supply of manure and inorganic fertilizers, target areas with low adoption to expand acreages, ensure timely holes preparation for increased adoption and the right spacing of the crop.

Consent

Before any interview, respondent's consent was sought.

Acknowledgements

The authors acknowledge Ministry of Agriculture staffs at Siaya County who were always willing to assist whenever called upon. The authors appreciation also goes to farmers and various improved mango value chain actors for agreeing to participate in this research study.

Competing interests

Authors have declared that no competing interests exist.

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